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Top Performer Survey: Computerized Psychological Assessment in Aircrew

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Top Performer Survey: Computerized Psychological Assessment in Aircrew

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There were 29 (80%) subjects from a squadron of 36 F-16 pilots who voluntarily participated in a newly developed anonymous, self-administered, computerized testing protocol. The test battery consisted of two 2.5-h blocks that gathered demographic information and measured personality (MMPI-2), cognitive capacity (MAB), crew coordination skills (PCI), and history of psychiatric diagnoses (C-DIS). The test battery also included a peer rating survey that collected information about the squadron's top performers and their personal qualities. Results indicated that aviators can agree who are top performers and what personal qualities are important in top performers. This pilot project demonstrated the success of the battery to gather aircrew information in a field location. Test data are presented.

THE DEFINITION of "the right stuff" in aviators has attained a mystical aura at times. If you know what it is, you don't need scientists to tell you; and if you don't know what it is, then you haven't been flying long enough. Nevertheless, questions remain largely unanswered scientifically: Are there identifiable and measurable personal/psychological qualities that define a successful military aviator? Are there differences between lead and wing aviators, other than flying experience? If aviators would offer details about themselves, their answers could lead to more focused training, improved selection criteria and enhanced mission performance.

Unfortunately, aviators are reluctant to submit to this type of questioning. There are at least three reasons for this. First, their responses on clinical tests might jeopardize their flying status. Second, the USAF has no standardized approach to psychological testing for gathering information at the squadron level. Without access to aviators at their locations, data collection occurs at locations convenient to scientists, and relies on select groups of aviators as subjects. These groups have been grounded aircrew seeking waiver, or special "high interest" groups required to undergo medical and psychological testing. Third, reporting a deficit is considered the admission of a weakness, and this is unacceptable within aviator group dynamics (10).

In approaching these barriers, we considered several studies that have documented greater truthfulness and privacy in subjects answering personal questions through computer query (12,21). Computerization also offered the flexibility of a consistent approach at any testing location, without needing highly specialized technical support. Finally, through computer query, aviators could give their responses anonymously, which we hoped would encourage both their participation and truthfulness.

For broadest applicability, psychological information is most useful when gathered from a truly representative group; in our case, the squadron. Although widely recognized as essential to a scientific basis of occupational mental health evaluations (20), the last normative psychological data derived on USAF aviators were completed by Fine and Hartman (6) in the early 1960's. These data, now more than 25 years old, are based on outdated instruments, and on a select group of aviators that flew quite different aircraft. In the last 10 years, other specialized aviator populations have been studied, such as undergraduate student pilots (16), and U.S. Army helicopter pilots (15).

Ashman and Telfer (2) reported on a group of 14 Royal Australian Air Force (RAAF) pilots from one Mirage squadron, but data were gathered only on the Edwards Personality Questionnaire. The current study of Air National Guard (ANG) aviators sought to gather information on four psychological tests from a squadron of successful F-16 aviators. In addition, a peer rating

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survey was developed to identify top performers in the squadron, and their personal qualities.

Some might consider the search for psychological differences among aviators analogous to sweeping a floor that has no dirt, because the expected psychological resilience of military aviato[illegible] proud heritage (1). However, psychiatric disord[illegible]act this population. One mission of the Neuro[illegible]atry Branch of the USAF Aerospace Medicine Consultation Service (ACS) of Armstrong Laboratory, Brooks AFB, TX, has been to consult with more than 280 aircrew in the last 10 years who have sought waivers for mental health difficulties. If we could learn more about the mental health concerns of the average successful aviator, preventive medicine models could be developed to reduce lost man years due to these problems.

METHODS

Development of the Test Battery

The subjects in this study completed standard p[illegible]chological tests and an epidemiologic survey pres[illegible] through notebook computer/software technology [illegible], following tests were chosen:

a) Minnesota Multiphasic Personality Inventory-2 (MMPI-2);
b) Computerized Diagnostic Interview Schedule (C-DIS);
c) Multi-Dimensional Aptitude Battery (MAB);
d) Personal Characteristics Inventory (PCI).

These tests offered a broad approach to measure different psychological characteristics of aircrew. The MMPI-2 is the newest version of the MMPI, a personality test that has become the most frequently administered psychological test (11). It is used at the USAF ACS to evaluate psychiatrically grounded aircrew who request a waiver to return to flying duties. Occupational norms have been developed for different populations (3,7); and Butcher (4) reported that at least one U.S. airline uses the MMPI as an adjunctive tool in employee selection. In a counter-balanced, repeated-measures study of the computerized MMPI versus the standard pencil and paper presentation, Honaker et al. (8) supported the software version of the MMPI's equivalency. While not specifically tested, the equivalency of the computerized MMPI-2 is generally accepted (14).

The National Institute of Mental Health's (NIMH) Diagnostic Interview Schedule (DIS) is a widely used epidemiologic survey developed by Robins and Helzer to screen the general population for the prevalence of psychiatric disorders (17). Up to now, there have been no reported attempts to define the prevalence of mental health disorders in the professional aviator population. This computerized version of the survey has been validated for test-retest reliability compared to the trained interviewer approach, and has shown good correlation in most diagnostic areas (3). Subject acceptance of the instrument as a self-administered questionnaire has been generally good (22).

The MAB is an IQ test developed by Douglas Jackson (9) that has a high correlation (0.94–0.98) with the WAIS-R. In general, the USAF aviator population has been noted to have above average IQ (6). It was expected that IQ might show a strong correlation to "top performer" aviators. Administered in 10 7-min blocks by computer with the use of an accompanying booklet, the computerized MAB measures verbal, performance, and full scale IQ. The subtests define ability scores on General Information, Comprehension, Arithmetic, Similarities, Vocabulary, Digit Symbol, Picture Completion, Spatial, Picture Arrangement, and Object Assembly.

Rose et al. (18) developed the PCI to assess "crew coordination qualities" in aviators. Some commercial airline corporations use it as part of their screening for pilot selection (5). It consists of 254 questions with a Likert scale response pattern. Aircrew responses are categorized into eight groups ranging from the "right stuff" to the "wrong stuff" in crew coordination. Already widely used in aerospace operations, it collects data more specific to aviation skills.

The overall format of the battery was arranged into two 2.5-h blocks, with a testing proctor supervising the use of the computers and preventing the two test sections from being completed by any one individual on the same day. Battery 1 consisted of demographic questions followed by the MMPI-2 and then by the PCI. Battery 2 contained the MAB followed by the DIS. To confirm confidentiality of answers, each subject's test responses were recorded on an individual 3.5-in data diskette identified externally by a random number. Test responses could not be accessed or scored without the computer scoring modules, which were unavailable at the squadron.

The peer survey (see Appendix A) was given to each pilot with Battery 2. The aviators were asked to identify the top three pilots (lead and two wingmen) in their squadron with whom they would fly combat. They could not select themselves. For each individual they chose, they also rank-ordered by importance four personal qualities from the list in Table I. These characteristics were a modified grouping from two sources: a NASA peer survey of astronauts (18), and a summary of "top pilot" characteristics suggested by past aces (13). This survey provided a frequency count of most chosen characteristics, and also offered a rank order of personal qualities in selected pilots.

After testing ended, each pilot's name and random numbers were known only to a disinterested third party (trustee) chosen by the squadron. Each subject's two random numbers were linked. The trustee also replaced the names of the top performers on the peer survey with their respective random numbers. Once completed, the key and the nameless surveys could be used to compare

TABLE I. PERSONAL CHARACTERISTICS RANK ORDERED BY PILOTS.

General Knowledge
Job Performance
Stress Tolerance
Leadership
Group Cohesiveness
Teamwork
Personality
Communication Skills
Aggressiveness

testing responses and personal qualities of top performers.

Subjects

There were 29 volunteers from an ANG F-16 squadron consisting of 36 pilots recruited as subjects. These 29 (29/36 = 80%) pilots completed the peer rating survey of top performers, defining characteristics of their selections. Demographic information was available for 23 pilots (64% of the 36 in the squadron; 79% of the 29 pilot subjects). All were male and none had ever divorced. Fig. 1 shows the range of experience in flying time in the F-16 and total military flying hours in the squadron. Table II reports the variety of demographic qualities in the participants.

Procedures

Data collection occurred over approximately 4 months, covering four active duty ANG weekends. All subjects initially signed a consent form which described the experiment, the anonymity of their data, and their right to terminate project participation at any time.

Descriptive statistics were run on the test results, peer surveys and demographics in this "pilot" project. Peer surveys were tabulated for the frequency of individuals chosen as top performers and their qualities. Data were analyzed using the Statgraphics statistical program.

RESULTS

There were 29 pilots (80% of the squadron) who participated in the psychological testing and voted for aviators to complete their preferred combat 4-ship. Of 87 possible votes (29 for lead and 58 for wingman), 3 aviators received 38 (38/87 = 48%). The same two pilots were chosen most frequently for both lead and wing positions. The third was chosen for wing position only; possibly, he lacked the upgrade qualification, or he had the most desirable characteristics to fill the wingman position. After these three pilots, votes were scattered for the rest of the aviators by votes of one or two. Although pilots who did not perform psychological testing got 21 votes (21/87 = 24%), the important qualities of all 4-ship aviators are known.

Qualities chosen for the lead and the two wingmen positions showed many similarities when considering total frequency counts (Fig. 2). However, when considering rank order (RO), the most chosen characteristics for lead were different from wingman position (Fig. 3). These results are an encouragement to continue the search to define the unique qualities of these aviator positions.

Scores for 15 pilots (51%) were available for the MAB. Mean scores were Verbal IQ = 125; Performance IQ = 127; and Full Scale IQ = 127. These scores were all in the Superior range of intellectual functioning.

TABLE II. DEMOGRAPHIC QUESTIONS. N = 23; 64% OF SQUADRON.

Question	Number	Percent
Combat Hours		
Yes	5	22
No	18	78
Rank		
Company Grade	13	57
Field Grade	10	43
Age		
30 years or younger	8	35
31 to 40 years	8	35
41 years or older	7	30
Education Level		
Undergraduate	18	78
Graduate	5	22
Previous Active Duty		
Yes	15	65
No	8	35

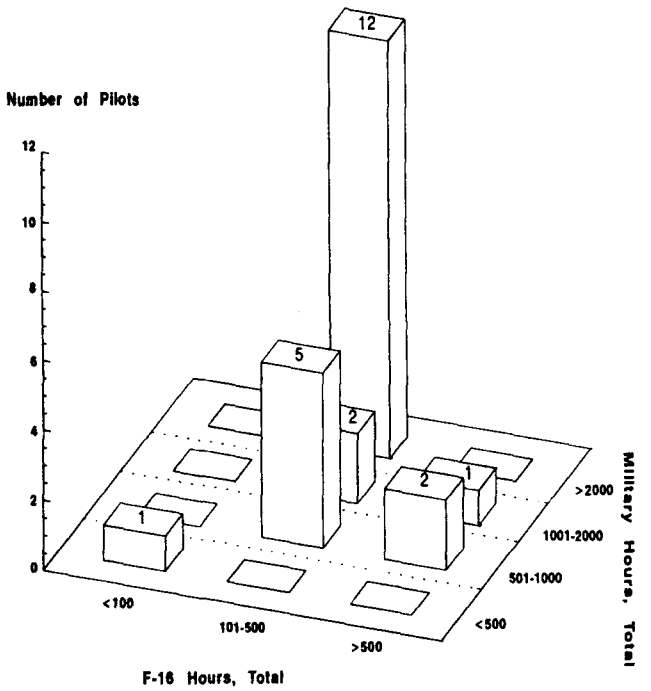

Fig. 1. Squadron flying hours and variety of flying experience. (n = 23; 64% of squadron.)

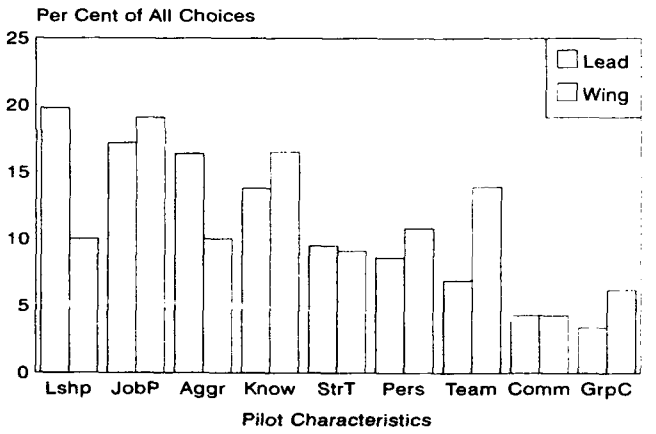

Fig. 2. Lead vs. Wing personal qualities. (n = 29; 80% of Squadron.) Lshp-Leadership; JobP-Job Performance; Aggr-Aggressiveness; Know-Knowleuge; StrT-Stress Tolerance; Pers-Personality; Team-Teamwork; Comm-Communication; GrpC-Group Cohesiveness.

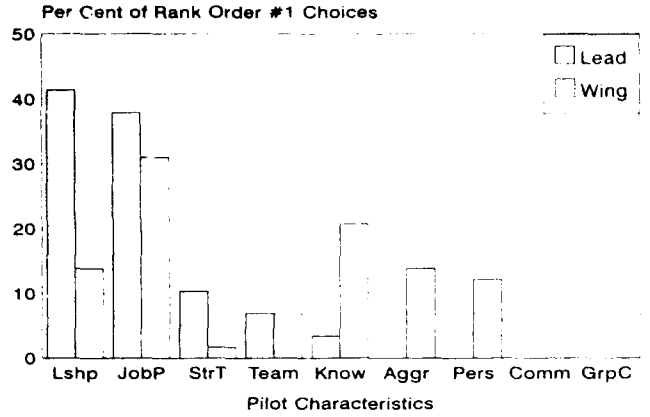

Fig. 3. Lead vs. Wing personal qualities rank ordered #1. (n = 29; 80% of squadron.) Lshp-Leadership; JobP-Job Performance; Aggr-Aggressiveness; Know-Knowledge; StrT-Stress Tolerance; Pers-Personality; Team-Teamwork; Comm-Communication; GrpC-Group Cohesiveness.

TABLE III. MAB SCORES. N = 15; 42% OF SQUADRON.

Scale	Raw Scores Mean	Raw Scores SD
Information	32.8	3.4
Comprehension	24.4	1.5
Arithmetic	17.4	1.7
Similarities	29.5	3.6
Vocabulary	36.7	5.2
Digit Symbol	28.5	3.8
Picture Completion	27.9	2.8
Spatial	36.5	5.2
Picture Arrangement	12.9	2.5
Object Assembly	16.2	2.9
Verbal Scale IQ	125.0	6.4
Performance Scale IQ	127.1	8.7
Full Scale IQ	127.3	6.6

All of the subtest means were elevated at least 1 SD higher than the general population normative sample (9), with Arithmetic, Vocabulary, and Digit Symbol subtests having the highest scores. MAB scores are summarized in Table III.

Scores from 23 (79%) MMPI-2 tests were obtained (Table IV). Of note was the reduced level of the fake bad scale (F) in this population. The clinical profile was within normal limits with expected low scores on physical health complaints (Hs), depressive complaints (D), acknowledging stereotypical gender roles (Mf), and comfort in social settings (Si). Higher scale means were noted on being optimistic (Hy) and being active, outgoing and energetic (Ma). This pattern of clinical scores was similar to that found in an earlier retrospective study comparing Army and Navy pilots' scores to older USAF norms (19).

TABLE IV. MMPI-2 SCORES. N = 23; 64% OF SQUADRON.

	Scale	Raw Scores Mean	Raw Scores SD	T Scores Mean
(L)	Lie Scale	3.8	1.9	51
(F)	Infrequency Scale	2.1	1.9	42
(K)	Supressor Scale	20.4	3.0	61
(Hs)	Hypochondriasis	1.7	1.2	48
(D)	Depression	15.3	3.8	43
(Hy)	Hysteria	22.2	3.7	53
(Pd)	Psychopathic Deviance	14.8	2.8	50
(Ma)	Masculinity-Femininity	21.6	4.4	41
(Pa)	Paranoia	9.5	2.2	48
(Pt)	Psychasthenia	4.6	3.0	47
(Sc)	Schizophrenia	5.0	3.4	48
(Ma)	Hypomania	16.2	4.2	51
(Si)	Social Introversion	17.5	5.9	40

PCI scores in 20 pilots (69%) were available. Participants' scores clustered into three groups regarding traits suited for multiplace aircraft crew coordination: Best (8/20 = 40%), Middle (8/20 = 40%), and Poor (4/20 = 20%). Goal seeking, achievement motivation, and interpersonal orientation were key qualities of the eight pilots in the "best" group. Eight "middle" group aviators had scores that fell into patterns thought to be neither helpful nor detrimental to crew resource management. However, high verbal aggressiveness, and low interpersonal orientation categorized four aviators into the "poor" group for crew coordination. None of the pilots taking the test scored in the "worst" group, which categorizes those individuals with undesirable scores on all PCI scales.

C-DIS data was obtained from five pilots (17%). In those respondents, only one showed a psychiatric diagnosis: nicotine dependence. Unfortunately, computer instructions in this initial trial confused many subjects who erroneously ended testing in Battery 2 before proceeding with the C-DIS.

DISCUSSION

The major goals of this project were the development and field testing of a computerized battery to gather normative psychological information about military aviators. Choosing the squadron as the closest group to a representative sample, we thought it optimal to take our tests to the field. To attain the goal of gathering information on clinical tests, anonymity was considered crucial. An ANG F-16 squadron with a range of ages and flying experience offered to participate in this innovative program.

This project considered the following five questions:

1) *What instruments should be included in a psychometric test battery for aircrew?*

The development of a computerized version of the PCI was one of the major accomplishments of this project. This custom-designed protocol queried a broad range of mental characteristics using tests that measured intelligence (MAB), personality (MMPI-2), crew coordination attitudes (PCI), and history of psychiatric health (C-DIS).

2) *What would aviators' scores reveal if they were to anonymously volunteer sensitive information about themselves?*

A total of 80% of this squadron participated in the testing. By maintaining anonymity, this battery revealed that pilots would voluntarily offer sensitive information about themselves and their peers. There were

29 peer surveys (80%), and 22 MMPI-2 (61%), 20 PCI (55%), 14 MAB (38%), and 5 DIS (13%) tests collected from the squadron pilots. These lower percentages were caused more by technical difficulties than by unwillingness to participate.

MAB findings confirmed a superior level of cognitive functioning among this group. It was not surprising that spatial performance mean scores were elevated, since right brain skills are often considered obligatory in flying (21). However, the rapid assessment of data needed to complete missions in changing environments might be reflected in the high mean values of the comprehension scores. The highest mean scores were in Arithmetic, Vocabulary, and Digit Symbol subtests, suggesting superlative left brain skills enhancing attention to detail, mathematical problem solving, and language skills.

PCI data demonstrated a range of groups in this squadron; with 80% falling into the best and middle groups, and 20% into what is considered the poor group. It might be surprising that no F-16 pilot participant scored in the worst group category for crew coordination skills. However, deployed in one or more pairs of aircraft, it is sometimes forgotten that single-seat fighter pilots still need crew resource management skills. Communication between pilots, and delegation and division of tasks are critical mission duties.

None of these aviators' MMPI-2 scores indicated current mental illness, suggesting that a lack of significant scale elevations could be a "measurable" factor in the successful military pilot. While pilot groups may be homogenous in certain areas like these, the PCI data revealed areas of individual diversity. Picano (15) has suggested that there is no "one type of personality" identified as best in selecting military aircrew. Our preliminary data lends support to the notion that a variety of different kinds of individuals are currently used to fly and complete the mission.

3) *Could aviators agree on their squadron's top performers?*

4) *Could they agree on the qualities important in those chosen?*

Squadron members did tend to agree about two of their top performers, choosing two individuals for lead and one for wing with a consensus (62%, 44%, and 12%, respectively) of their votes. Rank order #1 qualities were different for lead and wing positions. While both positions were expected to know their jobs well, higher skills in leadership and stress tolerance differentiated the lead pilot from the wingman who was expected to be more aggressive and personable (when considering rank order #1 qualities chosen). This battery can define the aviator qualities important to the squadrons that fly the missions. With more aviator participants, personal qualities of top performers can be studied.

5) *If truly normative data were gathered, would top performers' profiles be different?*

The question of correlations between top performers and their testing results remains to be answered. This testing protocol was a successful approach in obtaining data from a normative aircrew sample. With minor but necessary refinements, it could be widely implemented to study a range of aircrew who fly military aircraft. As the sample size grows, attempts can be made to define desirable personal qualities and testing profiles that significantly distinguish top performer aviators of each aircraft type from their fellow aviators.

Recommendations for Future Research

Multiple payoffs could result from wider aviator participation in this test battery. Aviator occupational psychometric norms could be updated, and aircraft specific norms could be developed. USAF psychiatric aircrew standards and ACS waiver recommendations would benefit greatly from the scientific update and expansion of normative data. Baseline cognitive measurements on aviators would become available, that could offer helpful comparison data in future health evaluations. Gathering information about aviators throughout their careers could yield important data about successful traits of long-term military aviators. Primary and secondary prevention of mental health difficulties would benefit aircrew (and mission) performance through data obtained with the C-DIS.

Attempts to correlate top performers' psychological profiles with their personal qualities, as seen by squadron mates, would be possible with sufficient aircrew participation. Data from this battery could enhance the preparatory training of future flight leads. Current USAF research into situational awareness, a skill thought to be highly related to combat survivability, could gain from information about top performers' personal qualities and their psychological profiles.

As the U.S. Armed Forces adapt to face the challenges of the 21st century, one thing will remain constant. The success of the flying mission will depend upon the capabilities and performance of the aviator. Payoffs follow an improved understanding of the psychological (human) factors of well-adapted aircrew. This test battery can gather information that will advance the future training of successful military aviators.

The data on personality (MMPI-2), intelligence (MAB), interpersonal qualities (PCI), incidence of psychiatric diagnosis (C-DIS) and peer ratings will lead to breakthroughs in the identification of the personal attributes military aviators need for success. The widespread acceptance of cockpit resource management training for aviators is one current example of the interface between psychological skills and effective aircrew mission performance. By identifying psychological factors of successful pilots and those personal qualities needed for lead and wing positions, this computerized tool will help project our understanding of the next generation of aviators into the 21st century.

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Our thanks to the following people for their dedicated support: SSgt Steve Chartier, Ssgt Gary Schofield, Sgt David Mizelle, and SrA Jacqueline Bonney. Without their willingness to work odd hours, to give up weekends with their families, and to dedicate their efforts to help aircrew, this project could not have been completed.

The voluntary, fully informed consent of the subjects used in this research was obtained as required by 169-6. Opinions, interpretations, conclusions, and recommendations are those of the author and are not necessarily endorsed by the U.S. Air Force. The research reported in this paper was supported by the Armstrong Laboratory, Human Systems Center, AFMC, United States Air Force, Brooks AFB, TX.

APPENDIX A. PEER SURVEY

Choose from your squadron those three other pilots you would want to fill your four-ship for combat, and place their names in the spaces below. Considering those qualities on the facing page, name those that were most important in your choices and rank these in the spaces provided beneath each name (most important #1, next most important #2, etc. #3, #4).

Remember that we are looking for the "best" person you feel will fill each job, but DO NOT choose yourself.

Lead:	1st Choice Wingman:	2nd Choice Wingman:
_____ (name)	_____ (name)	_____ (name)

[Trustee: remove top portion of this form and destroy]

What qualities were most important in choosing this person?

#1. _____	#1. _____	#1. _____
#2. _____	#2. _____	#2. _____
#3. _____	#3. _____	#3. _____
#4. _____	#4. _____	#4. _____

Trustee use only for random number assignments:
_____ _____ _____

Aircrew member: Trustee will simply separate names from top of page and send bottom of page with assigned random numbers to principal investigator.

RATING CATEGORIES

1. GENERAL KNOWLEDGE
   - possesses a good fund of information
   - absorbs new information quickly
   - reduces complex issues to essential elements
   - valued for opinions on technical matters
2. JOB PERFORMANCE
   - accomplishes any task thoroughly and efficiently
   - uses initiative to solve difficult problems
   - is predictable, consistent, reliable in performance
   - able to prioritize multiple critical tasks quickly
3. STRESS TOLERANCE
   - demonstrates prompt and accurate reactions
   - effective in an unexpected emergency
   - effective under prolonged periods of stress
   - arrives at practical conclusions in emergencies
4. LEADERSHIP
   - motivates others to complete tasks
   - delegates work and allows person to complete task
   - is decisive/flexible when required
   - has determination and projects decisiveness
5. GROUP COHESIVENESS
   - puts group goals ahead of individual goals
   - shares credit and accepts blame
   - tolerant of individual/cultural differences
   - works effectively with many different people
6. TEAMWORK
   - easy to get along with, good sense of humor
   - pulls own weight (does own share of undesirable tasks)
   - gives and accepts feedback/criticism well
   - good listener
7. PERSONALITY
   - tolerates difficulties and frustration well
   - few irritating qualities
   - personable and amiable
   - self-sufficient, motivated, self-starter
8. COMMUNICATION SKILLS
   - presents self well; speaks clearly and effectively
   - represents squadron well
   - concise and focused
   - gets point across
9. AGGRESSIVENESS
   - pursues goals rather than waiting for them to occur
   - accepts calculated risks
   - "makes" opportunities where few seem to exist
   - desire to excel

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